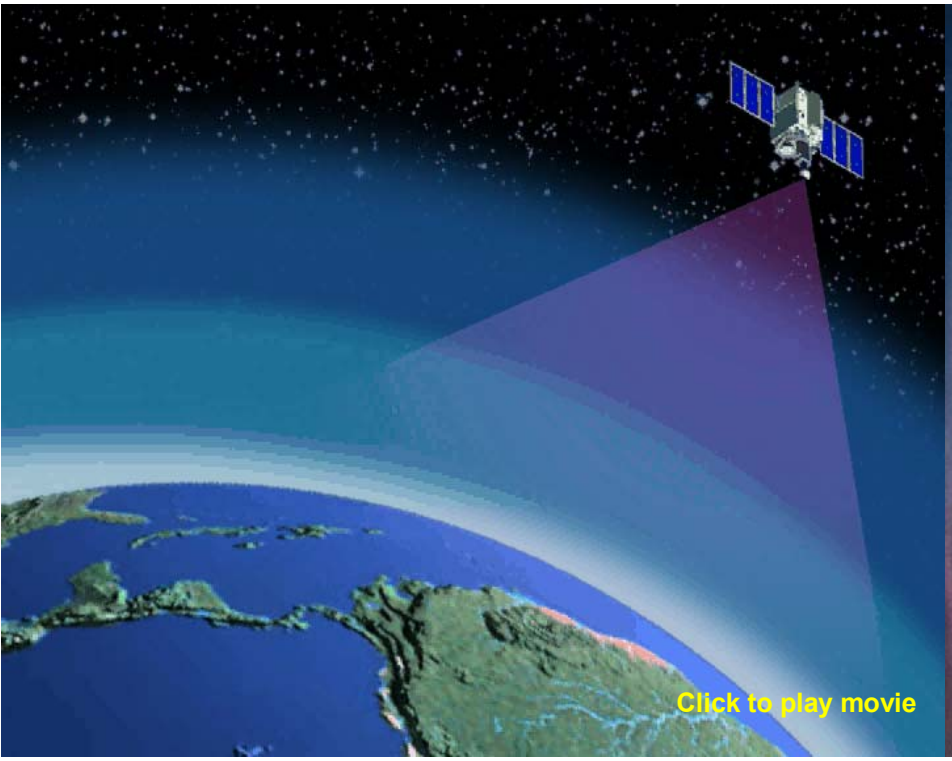
Advanced Satellite Aviation-weather Products

ASAP: Advanced Satellite Aviation-weather Products

Weather Accident Prevention Program, John Murray, LaRC, 11/20/02



ASAP: A NASA AvSP/GIFTS/FAA AWRP partnership to infuse high-resolution satellite data into aviation weather products for ground and airborne users.

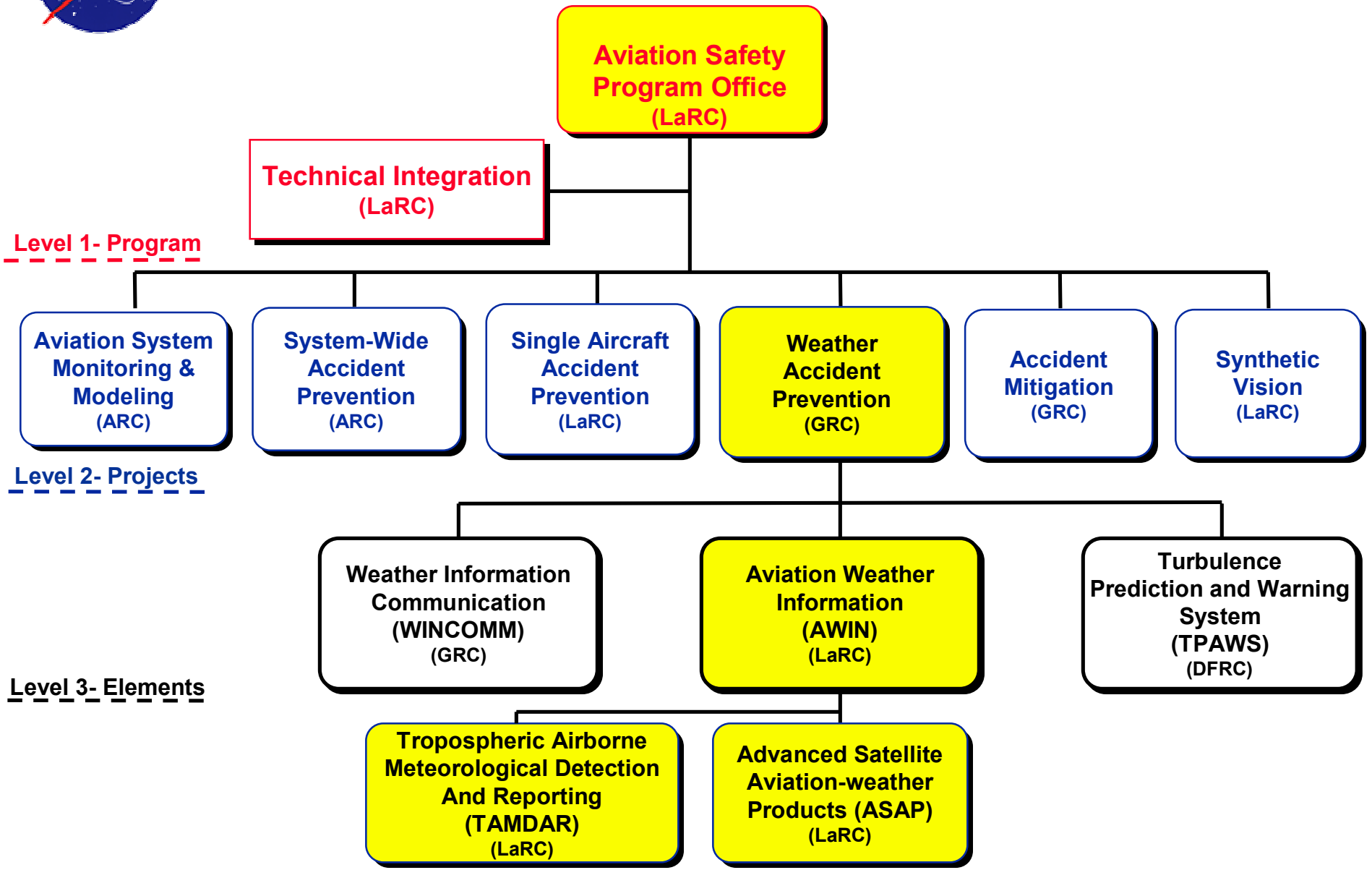
ASAP Background and Impact

ASAP: Advanced Satellite Aviation-weather Products

- **GOES soundings were not utilized operationally for the first three years of availability so CONNTRO was formed by the NASA ESE and NOAA NESDIS.**
- **Currently only 14% of the sounding information available from GOES is used operationally.**
- **The FAA AWRP does not currently employ satellite soundings quantitatively.**
- **Targeted AWRP products can benefit from the infusion of satellite sounding and imagery data.**
- **ASAP will improve Aviation Safety.**
  - **Frequent, high-resolution observations including remote areas**
  - **Greatly improved aviation weather analyses and forecasts**

Aviation Safety Program Organization

ASAP: Advanced Satellite Aviation-weather Products



The ASAP Interagency Team

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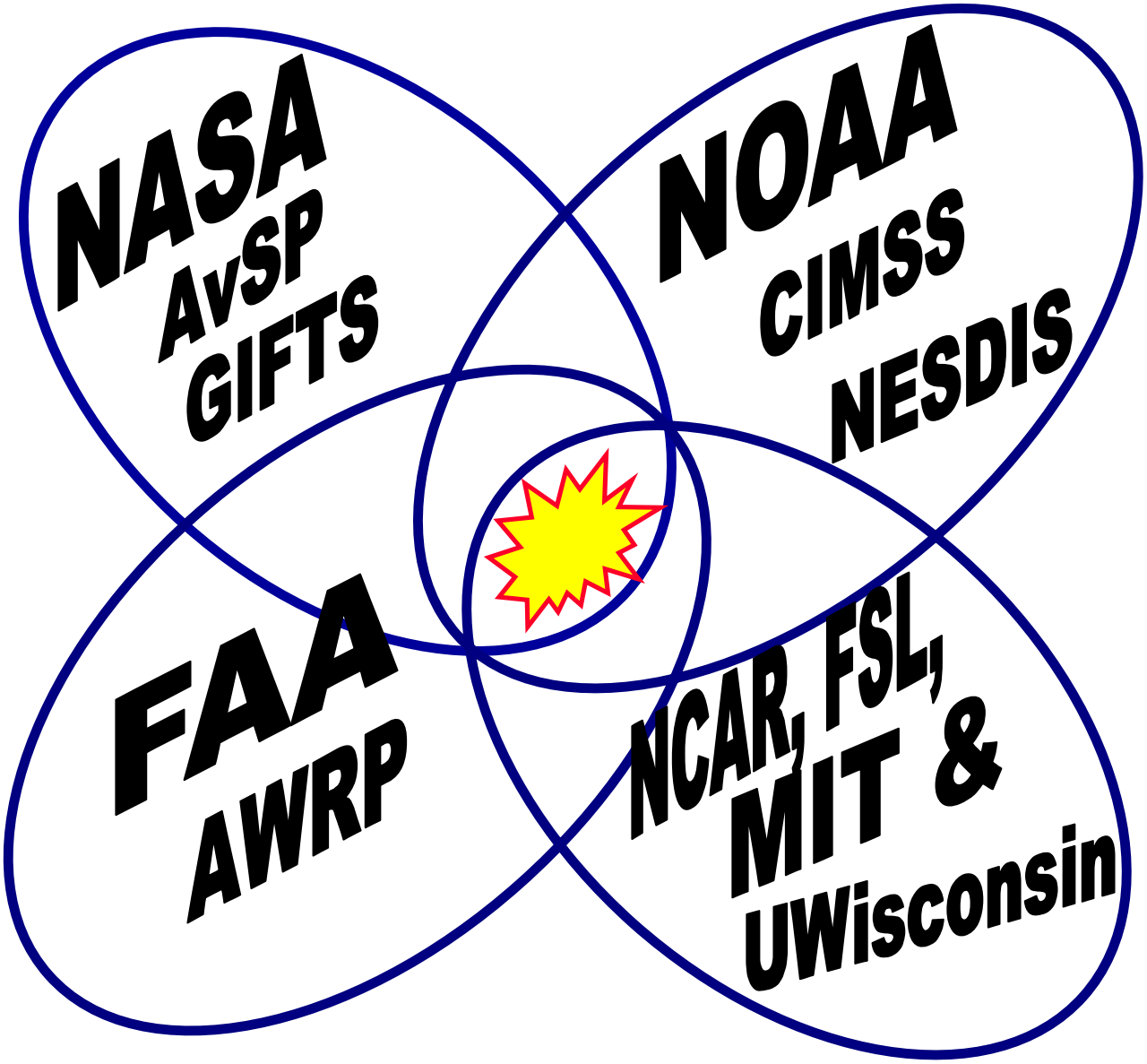

ASAP - Advanced Satellite Aviation- weather Products

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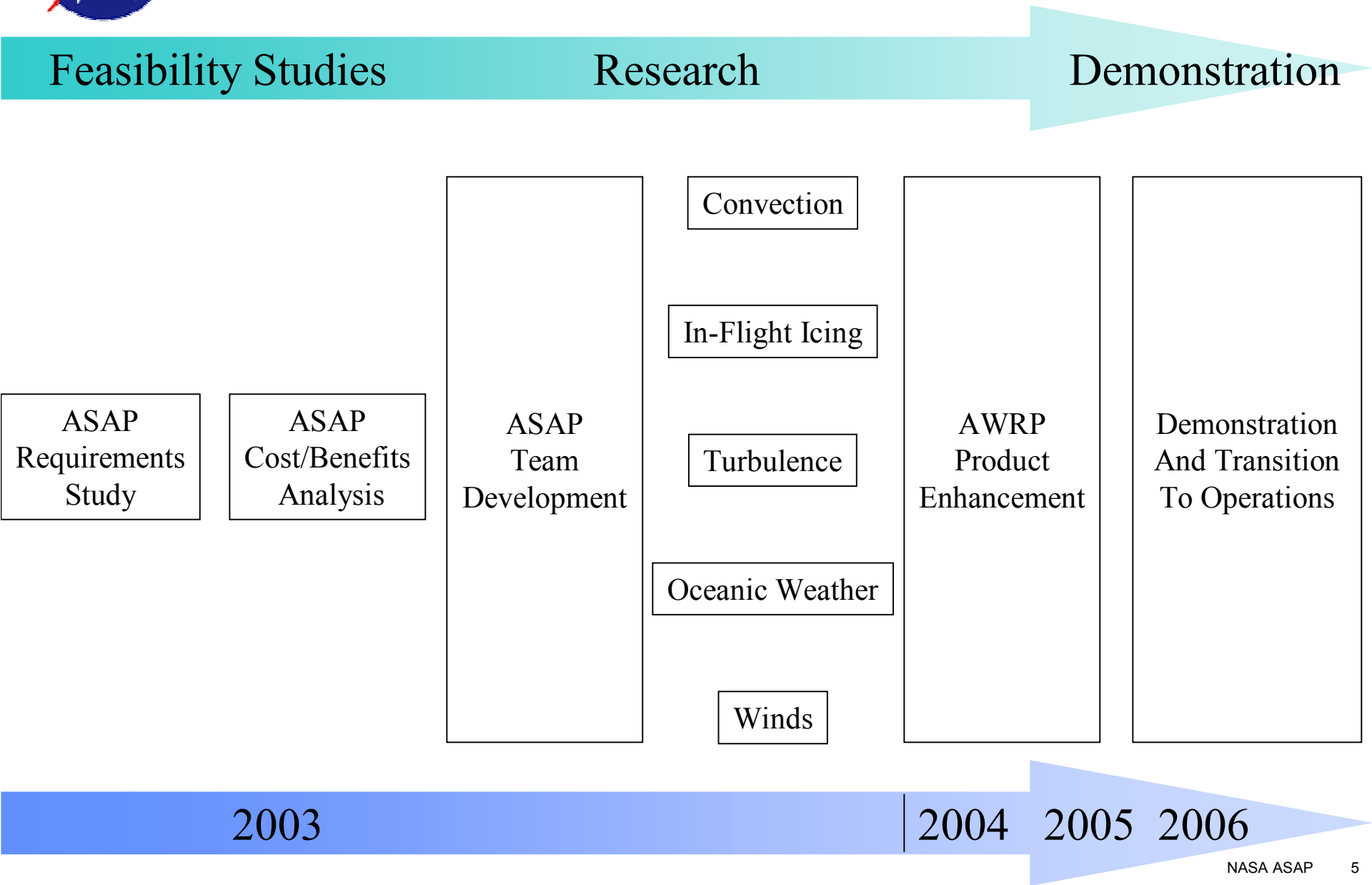
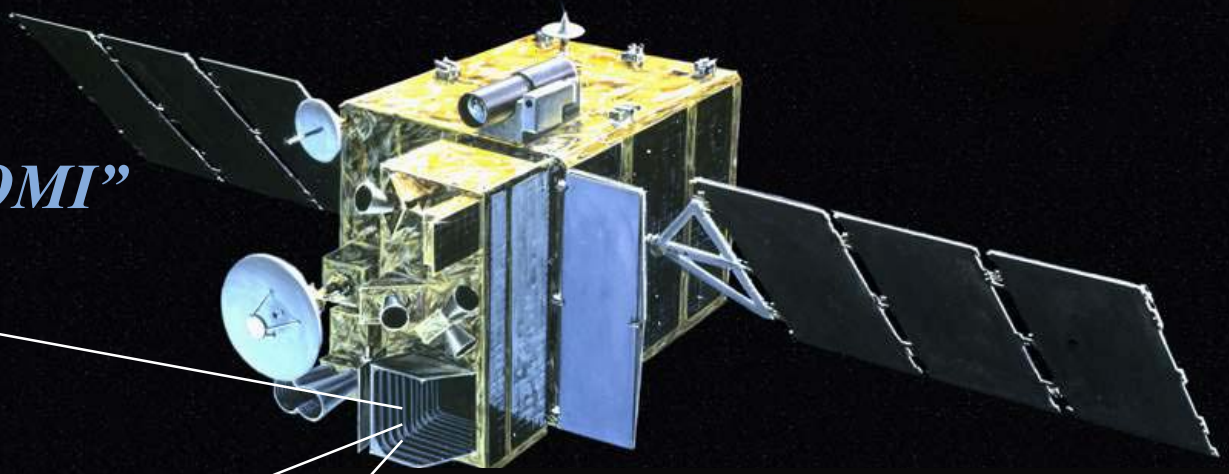


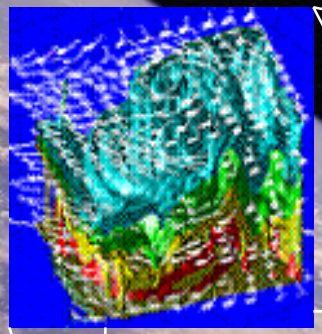
Geostationary Imaging Fourier Transform Spectrometer

GIFTS – *A revolutionary weather forecast tool*

New Technology for Atmospheric Temperature, Moisture, & Winds

EO-3 "GIFTS-IOMI"





4-d Digital Camera:

Horizontal: Large area format Focal Plane detector Arrays

Vertical: Fourier Transform Spectrometer

Time: Geostationary Satellite

GIFTS Spectral Coverage

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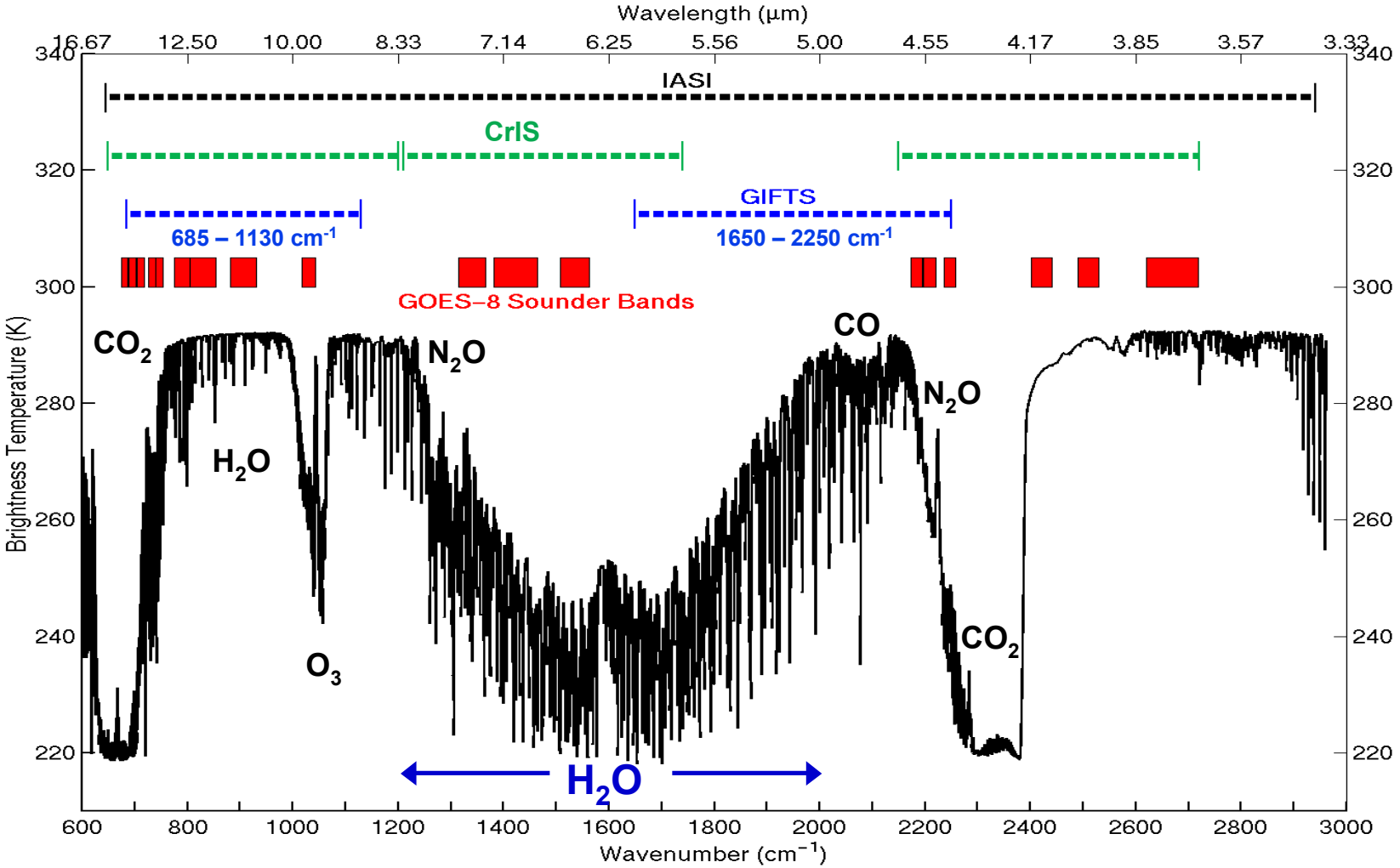
High Spectral Resolution = High Vertical Resolution



GIFTS is Optimized for Temperature and Water Vapor Sounding

Airborne Sounding Concept

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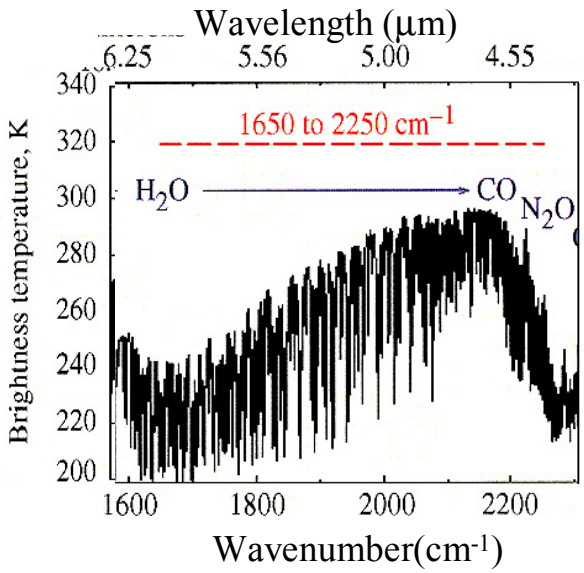
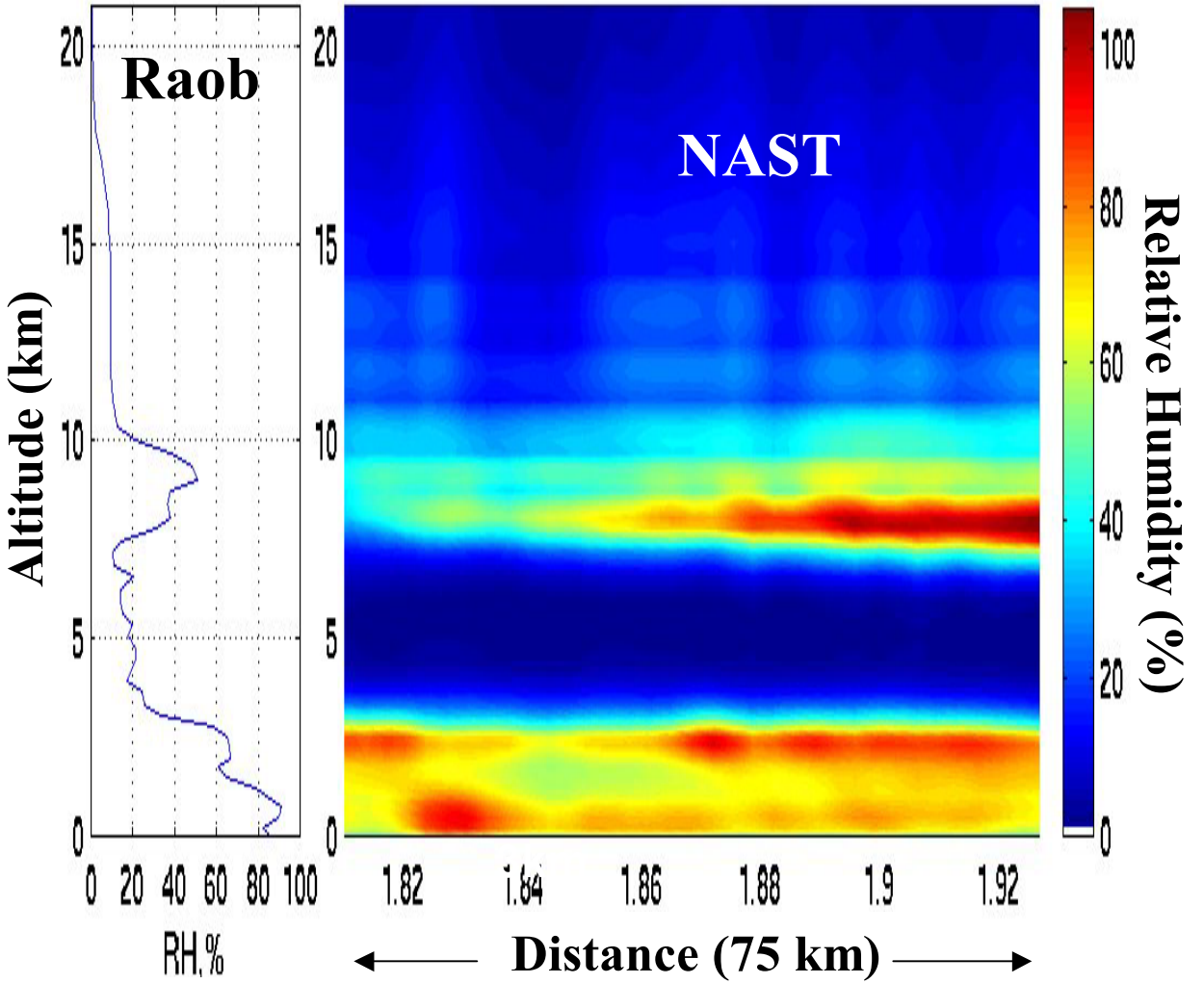
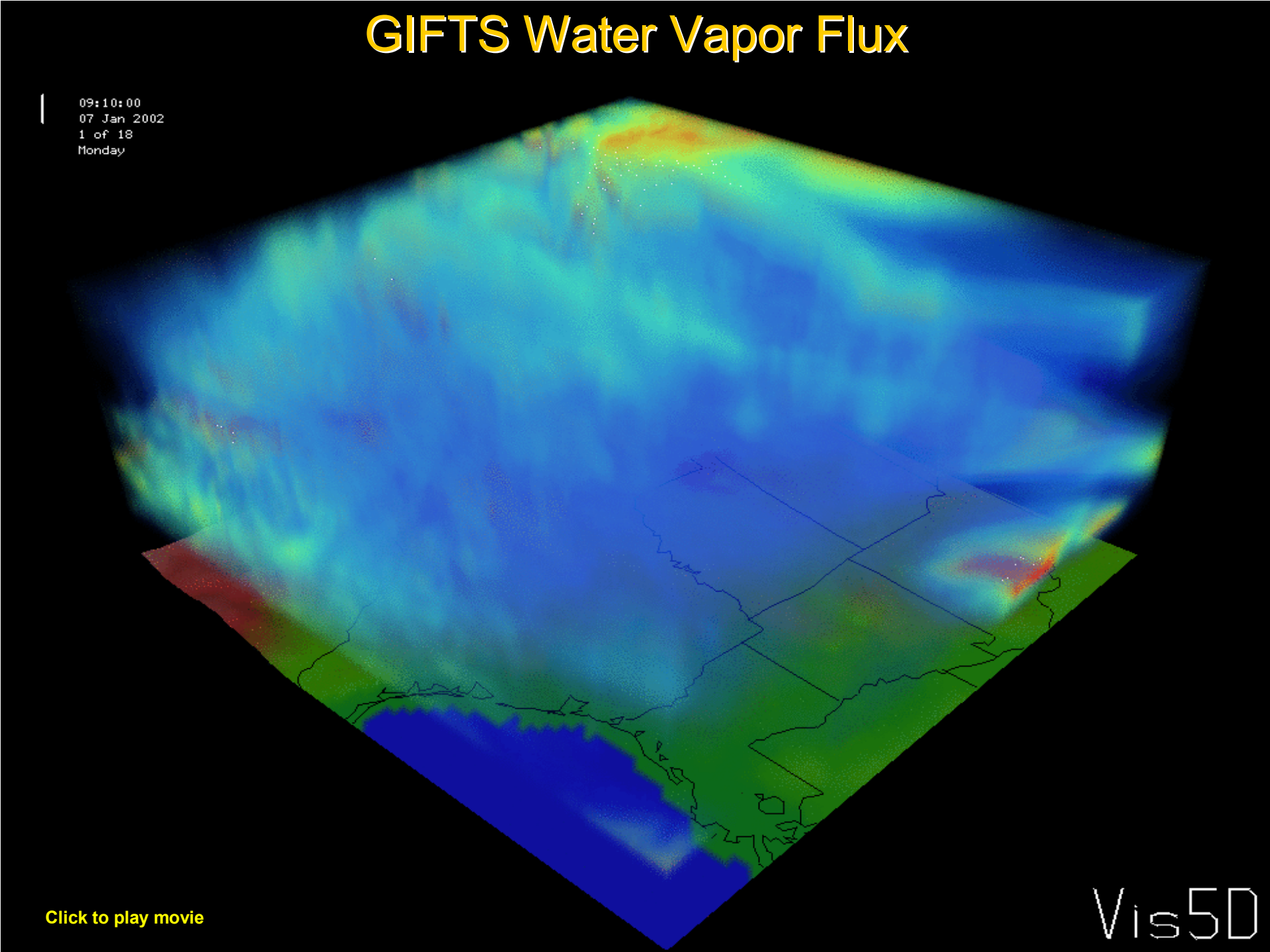
Airborne Demonstration of Concept: 1-2 km vertical resolution water vapor profile measurements

H_2O Radiance Spectrum →





GIFTS Water Vapor Flux

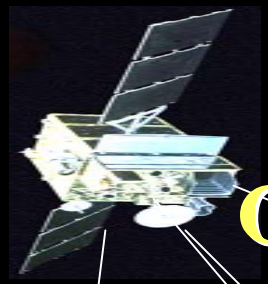


The Significance of GIFTS

Observation Capability Will Revolutionize Weather Forecasting

- **Nowcasting** (rapid measurement update)
- **Numerical prediction** (initial p,T,q,V data)
- **Hurricane landfall** (steering wind profiles)
- **Tornadic storms** (stability change monitoring)
- **Air quality forecasts** (O_3 and CO transport)

NASA Earth Science Enterprise
Enabling Precise Characterization of the Atmosphere



GIFTS

CALIPSO

CloudSat

Aqua

PARASOL

Aura

NPP/NPOESS

Satellite Data Infusion into Aviation Weather

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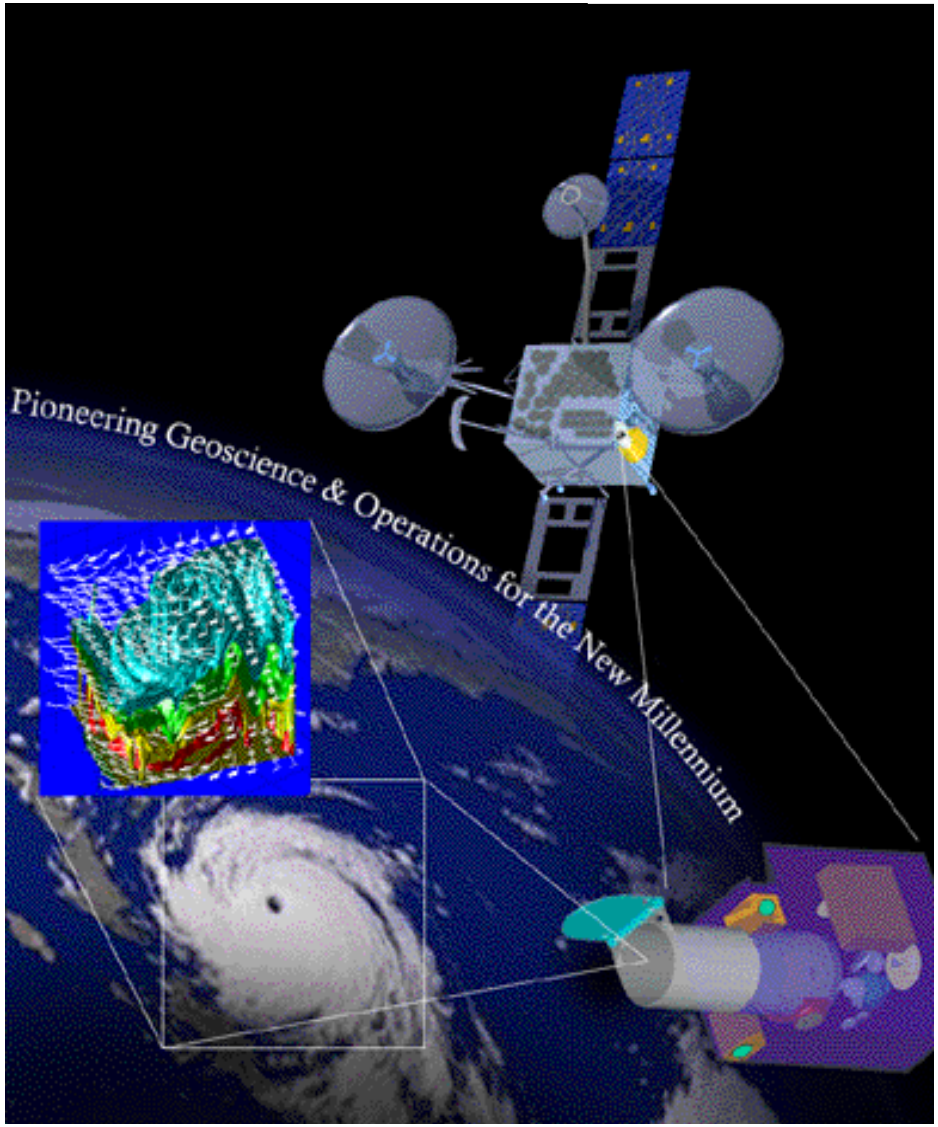

FAA AWRP Product Development Teams:

- In-Flight Icing
- Aviation Forecasts and Quality Assessment
- Turbulence
- Winter Weather Research
- Convective Weather
- Terminal Ceiling and Visibility
- National Ceiling and Visibility
- Model Development and Enhancement
- Oceanic Weather

From Research to Applications…

ASAP: NASA Earth Science Enterprise & Aviation Safety Program Develop GIFTS Aviation Weather Applications

ASAP Objectives

1. Flight Level Winds
2. Convective Initiation
3. Aviation Turbulence
4. In-flight Icing
5. Oceanic Weather

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Product Accuracy: 2002

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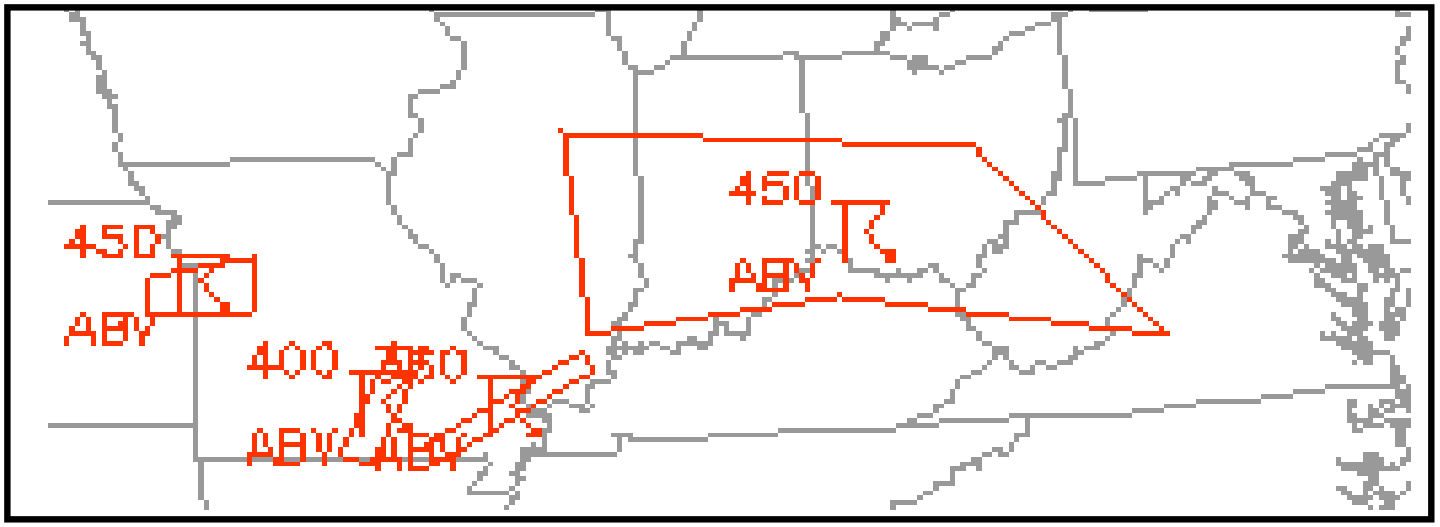
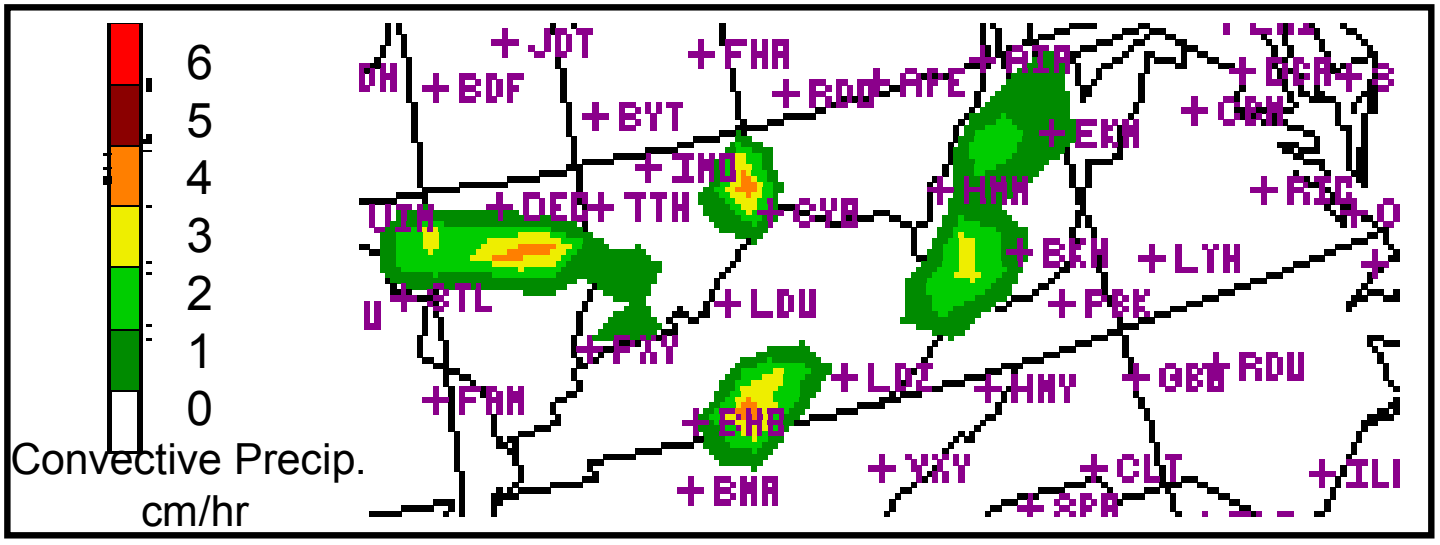
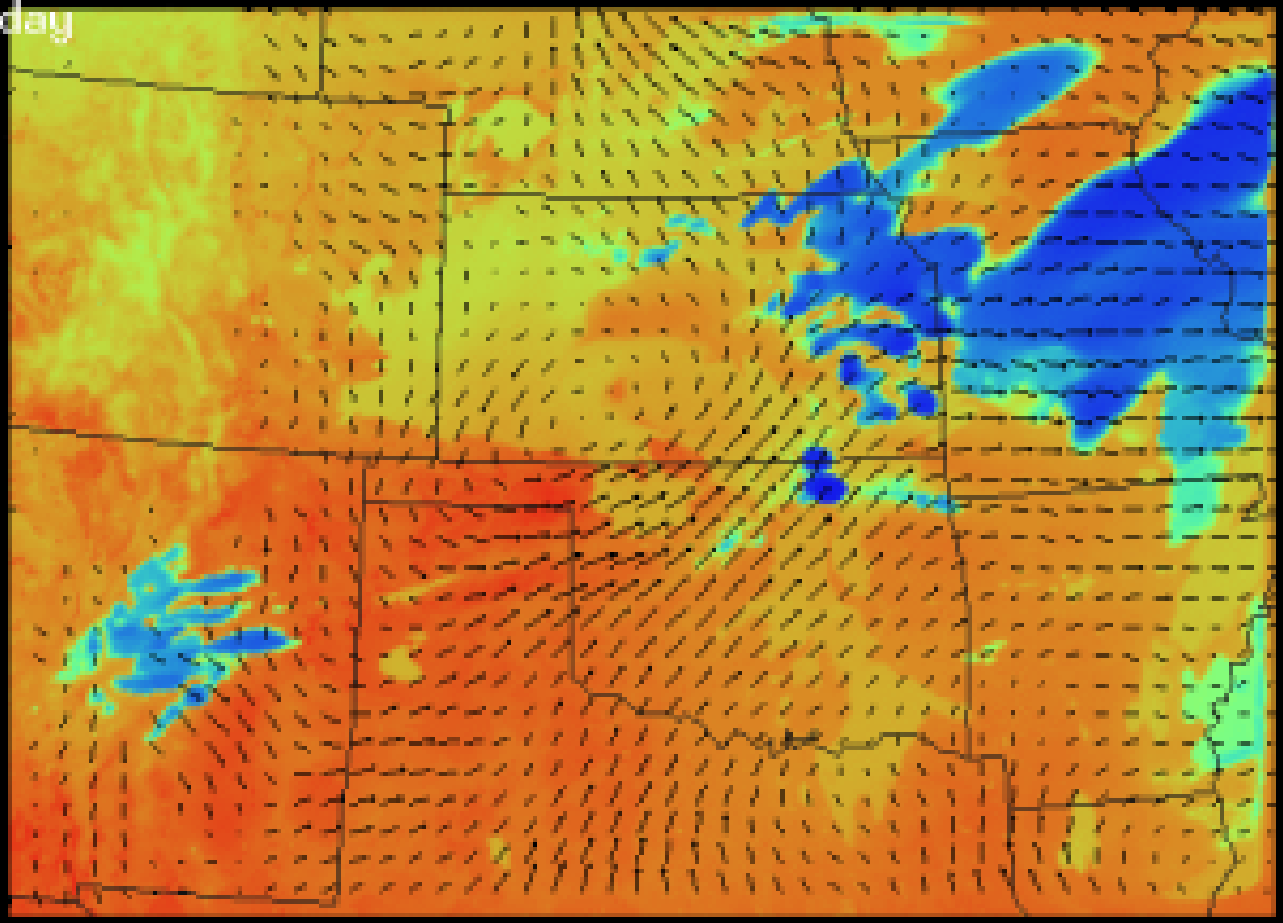
Convective SIGMET Warning at 1200Z 07 May 2002





GOES Convective Weather Depiction

16:50:00
12 Jun 1902
1 of 3
Friday

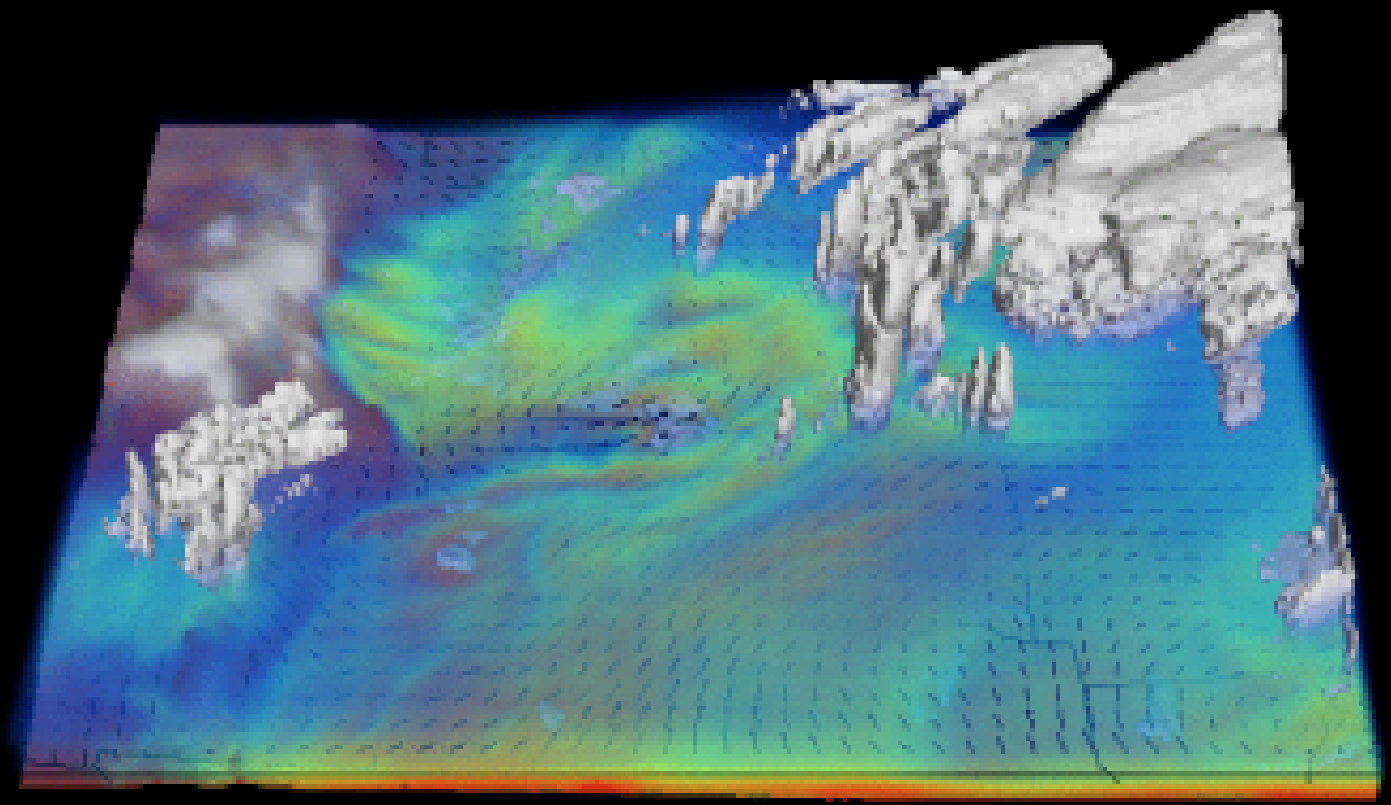


Click to play movie

Vis5D

GIFTS Will Image Convective Initiation

16:50:00
12 Jun 1902
1 of 3
Friday



Click to play movie

Vis5D

Product Timeline Distinction

ASAP: Advanced Satellite Aviation-weather Products

- **Black** text indicates that ASAP possesses the capabilities to produce the listed products *today with current remote sensing systems* (e.g. GOES).
- **Blue** text indicates that *over the next 1–4 years*, ASAP will have remote sensing systems and the scientific procedures to adequately use these data to produce the products.
- **Red** text indicated that *within 5 to 10 years*, ASAP will possess the data and capabilities to develop and produce the listed products. Use of experimental instruments in the interim allow us to state this with high confidence.

Convective Weather

ASAP: Advanced Satellite Aviation-weather Products

Potential Satellite Products:

- Cloud Typing
- Automated Detection of Convective Clouds, Cloud Lines
- Automated Detection of Convective Initiation
- GOES Sounder (CAPE, LI, Tskin, etc)
- AERI's ability to Detect Elevated "Capping" Inversion; Measure CAPE, CIN, θ_e-gradients

- Possibilites for detection of Elevated Convection (GOES-ABS)
- Outflow Boundaries - Automated Detection (GOES-ABI/ABS)
- Lagrangian Model for Nowcasting

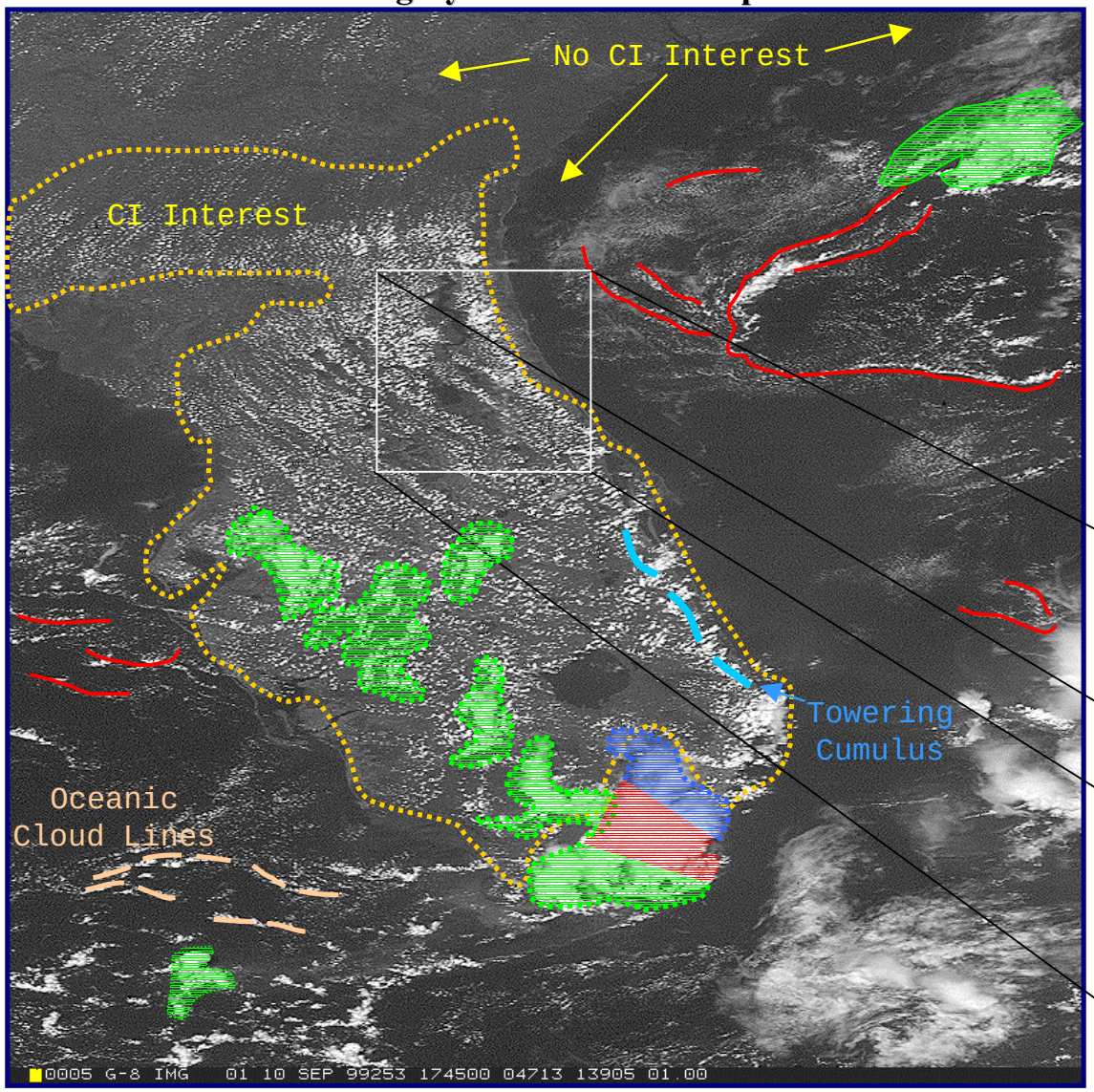
- Improved abilities with GOES-ABS/ABI, and GIFTS (In-flow and entrainment for lifecycle)

Convective Initiation (CI)

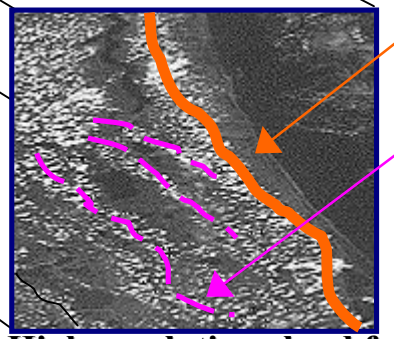
ASAP: Advanced Satellite Aviation-weather Products

Determined from Geostationary Satellite Data: *Precursors to CI*

GOES-8 1 km visible imagery: 17:45 UTC 10 September 1999



- General CI Interest Field
- Growing/Expanding Cumulus
- Deep Precipitating Cb's
- Cirrus Shield (no interest)
- Outflow Boundaries
- ABL Rolls/Cumulus Lines
- Sea-breeze Boundary



High-resolution cloud features

Turbulence

Potential Satellite Products:

- Convective Cloud Information/Pattern Recognition and Trends
- Convective Outflow Boundaries
- Initiation Region of Convection
- Wave Cloud detection (Convection-induced gravity wave regions)
- 4-D visualization
- MODIS 1 km water vapor bands
- 6.7 minus 11 μm with GOES imager

- Improvement to existing capabilities with GOES-ABI (multiple WV bands and 9.7 μm, 2 km, 5 minute refresh)

- All turbulence products improve with GIFTS/GOES-ABS
- Exploit GOES Sounder Total Ozone (better with GIFTS)

Clear Air Turbulence

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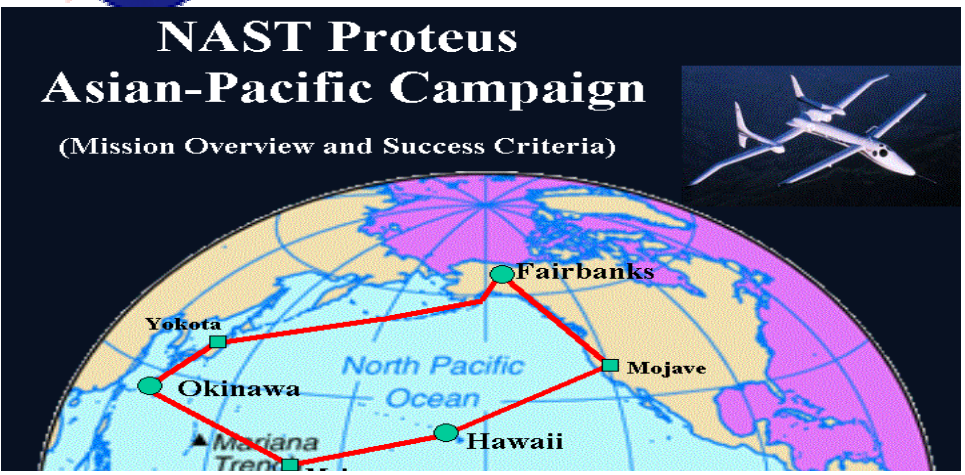
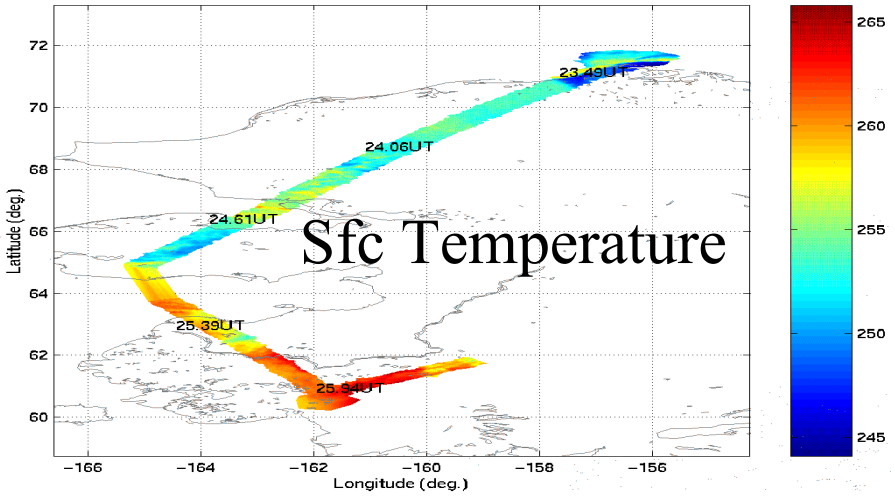
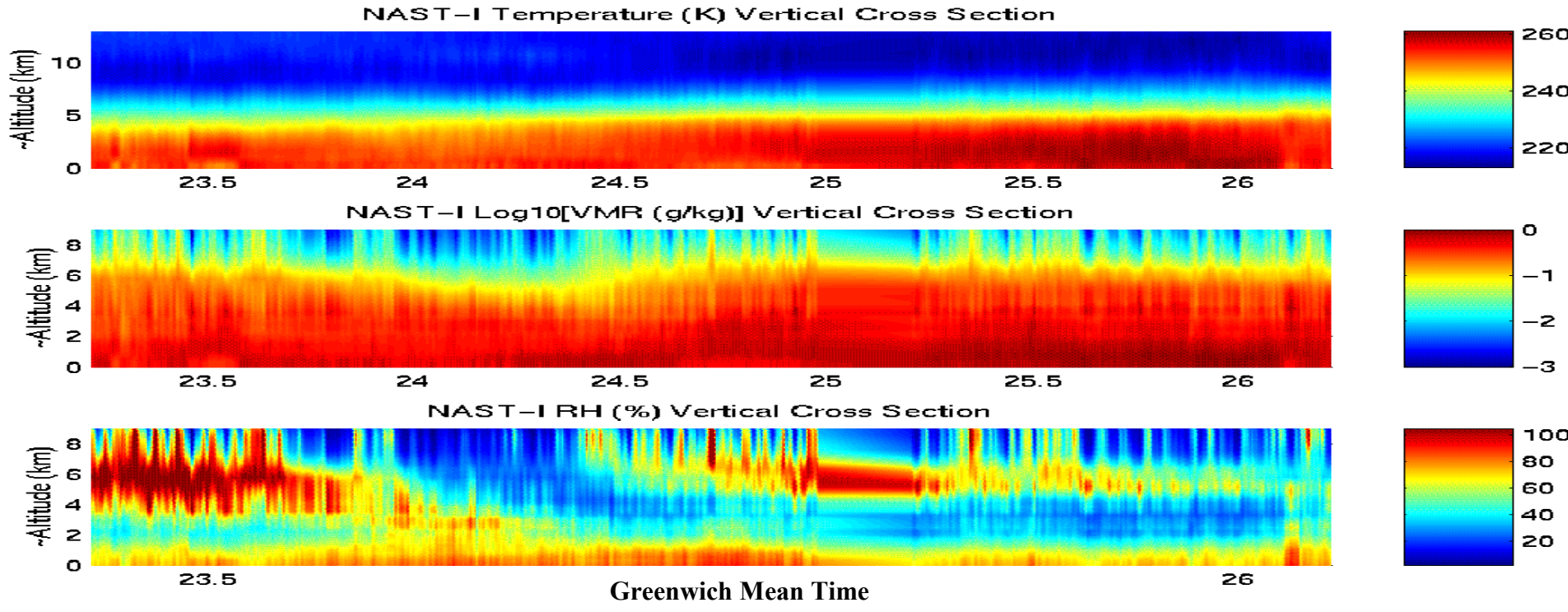
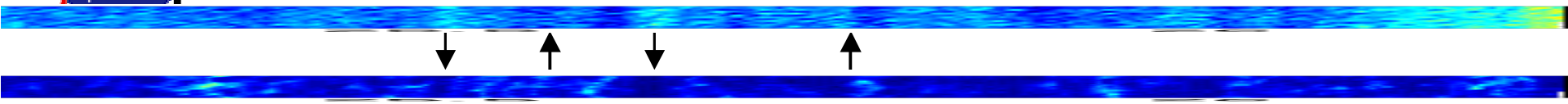






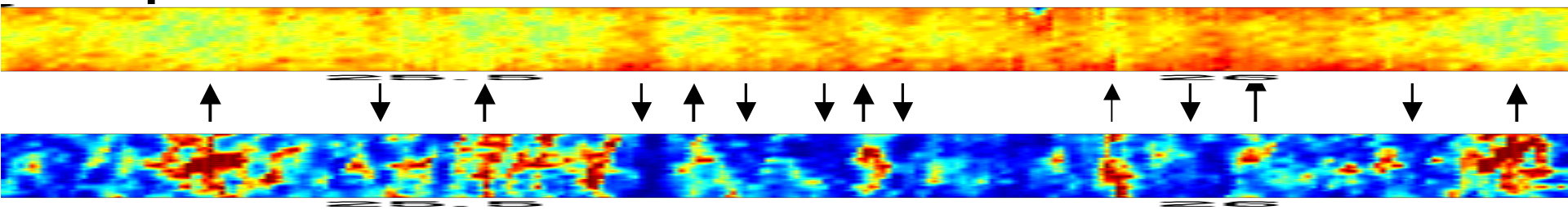
NAST and CAT ??

ASAP: Advanced Satellite Aviation-weather Products

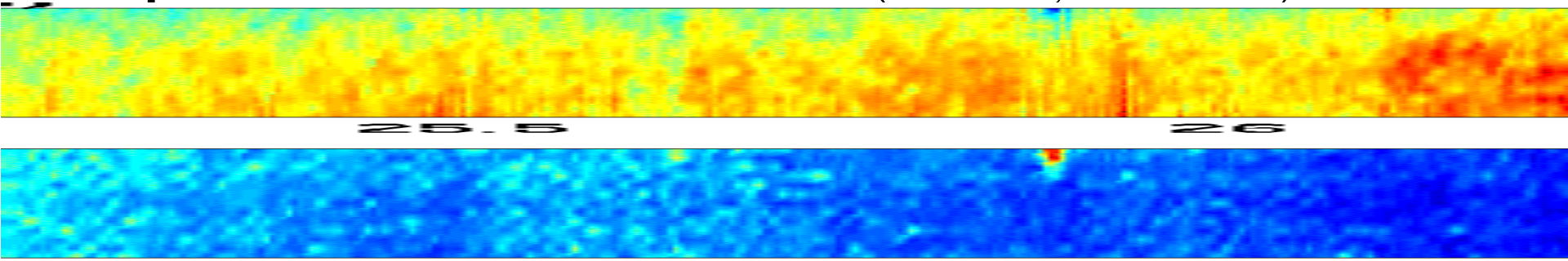


Weak Turbulence Signatures at 150 mb

Downdrafts: Warm & Dry Updrafts: Cold & Moist



Strong Turbulence Signatures at 300 mb



No Turbulence Signatures at 500 mb

In-Flight Icing PDT

Potential Satellite Products:

- Synthetic Satellite Imagery (MM5 and RUC-2)
- 4-D Visualization
- Minnis/Smith Cloud top algorithm suite
  http:

- Use of AVHRR for Cloud Typing products

- MODIS Mixed Phase cloud product (correlate with icing reports)
- Microwave from POES satellites

- Improved Fog Products with GOES-ABI (8.5 µm and 1.6 µm, 2 km, 5 minute updates)

Oceanic Weather

ASAP: Advanced Satellite Aviation-weather Products

Potential Satellite Products:

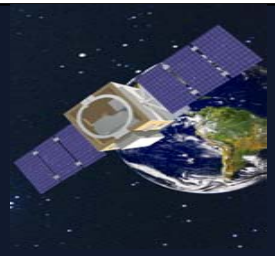
- GOES (+MTSAT) SST
- Locating Jets (Jet Streaks) with Imager Winds; Shear Zones
- Sounder Water Vapor Winds
- "CO2 Slicing" for Height of Volcanic Plume
- Sounder Ozone
- 0.47 μm and Visibility; Aerosol and Smoke Detection
- Turbulence and Convection

- 8.5 μm on MODIS/ABI/ABS for volcanoes
- Contrails

- Better SST with ABI (better cloud-clearing, etc)
- Better with GIFTS/ABS (clean micro-windows)

ASAP Production and Delivery

ASAP: Advanced Satellite Aviation-weather Products



ASAP: Developing High-Resolution Satellite Weather Products to Improve Aviation Safety

NASA ASAP

FAA AWRP

Government and University Labs

NOAA NESDIS

NOAA NCEP

NOAA AWC

AWIN Providers

FAA FSS

Airline Ops